

## CLAIMS

1. A color proofing method for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press, the color proofing method comprising the steps of:

creating a look-up table containing converted values of image data over the entire color space with respect to the proof press;

correcting the look-up table based on the color of printing paper for the printing press and a paper exposed area factor in the proof print; and

making proof print by the use of the corrected look-up table.

2. The color proofing method according to claim 1, wherein in the case where the proof print is produced based on area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink transmittance into account, the step of correcting the look-up table includes the steps of:

determining a paper exposed area factor  $\alpha$  in accordance with the following equation when arbitrary reference data P in the look-up table has color values (Cp, Mp, Yp, Bkp), each of which is N-bit data:

$$\alpha = (1 - Cp / (2^N - 1)) \times (1 - Mp / (2^N - 1)) \times (1 - Yp / (2^N - 1)) \times (1 - Bkp / (2^N - 1)),$$

in contrast, determining the paper exposed area factor  $\alpha$  in accordance with the following equation when the arbitrary reference data P in the look-up table has the color values (Cp, Mp, Yp, Bkp), each of which is percentage data:

$$\alpha = (1 - Cp / 100) \times (1 - Mp / 100) \times (1 - Yp / 100) \times (1 - Bkp / 100); \text{ and}$$

determining corrected values (Ci', Mi', Yi', Bki') of color values (Ci, Mi, Yi, Bki) of arbitrary reference data I in the look-up table in accordance with the following equations when color values (Ca, Ma, Ya, Bka) of the printing paper for

the printing press are added to a part where a paper exposed area factor is 100%:

$$Ci' = Ci + Ca \times \alpha, Mi' = Mi + Ma \times \alpha, Yi' = Yi + Ya \times \alpha \text{ and } Bki' = Bki + Bka \times \alpha,$$

to thus replace the color values of the reference data with the corrected values.

3. The color proofing method according to claim 1, wherein in the case where the proof print is produced based on both of density gradation and area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink transmittance into account, the step of correcting the look-up table includes the steps of:

specifying an influence range defining how far reference data is influenced in the color space when the color values of the printing paper for the printing press are added to the color space; and

determining an influence value for each of the reference data based on the color values of the paper and the value of the influence range, to thus add the influence value to the reference data.

4. The color proofing method according to claim 1, wherein in the case where the colors of the printing paper for the printing press and a printing paper for the proof press are different from each other to such an extent as to need to take the ink transmittance into account, the step of correcting the look-up table includes the step of:

determining corrected values ( $Ci'$ ,  $Mi'$ ,  $Yi'$ ,  $Bki'$ ) of color values ( $Ci$ ,  $Mi$ ,  $Yi$ ,  $Bki$ ) of arbitrary reference data I in the look-up table in accordance with the following equations when color values ( $Ca$ ,  $Ma$ ,  $Ya$ ,  $Bka$ ) of the printing paper for the printing press are added to a part where a paper exposed area factor is 100%,

wherein address values (Cid, Mid, Yid, Bkid) express the color values (Ci, Mi, Yi, Bki) by N-bit:

$$Ci' = Ci + Ca \times (1 - Cid / (2^N - 1) \times Mid / (2^N - 1) \times Yid / (2^N - 1) \times Bkid / (2^N - 1));$$

$$Mi' = Mi + Ma \times (1 - Cid / (2^N - 1) \times Mid / (2^N - 1) \times Yid / (2^N - 1) \times Bkid / (2^N - 1));$$

$$Yi' = Yi + Ya \times (1 - Cid / (2^N - 1) \times Mid / (2^N - 1) \times Yid / (2^N - 1) \times Bkid / (2^N - 1)); \text{ and}$$

$$Bki' = Bki + Bka \times (1 - Cid / (2^N - 1) \times Mid / (2^N - 1) \times Yid / (2^N - 1) \times Bkid / (2^N - 1));$$

to thus replace the color values of the reference data with the corrected values.

5. The color proofing method according to any one of claims 1 to 4, wherein the step of creating the proof print includes the step of:

changing image data converted by using the corrected look-up table based on the previously determined noise strength and distribution amount indicating the level of a variation of the color of the printing paper for the printing press, to thus make the proof print by the use of the changed image data.

6. A color proofing method for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press, the color proofing method comprising the step of:

correcting proof printing image data, in which each of levels of monochromatic color gradation of black on the printed matter is represented on the proof print, out of the proof printing image data over the entire color space in a subtractive process resulting from color matching between proof print produced by the proof press and the printed matter to be produced by the printing press in such a manner that a part having a black ink area factor of 100% on the printed matter is represented only with black ink also on the proof print, but that a part other than the part having a black ink area factor of 100% on the printed matter is represented on the proof print by using under color removal, to thus reproduce, on the proof print,

the representing characteristics of the black ink on the printed matter.

7. The color proofing method according to claim 6, wherein the step of correcting the proof printing image data includes the steps of:

finding  $\min(C_{100}, M_{100}, Y_{100})$  from color values  $(C_{100}, M_{100}, Y_{100}, Bk_{100})$  of the proof printing image data for representing, on the proof print, the part having the black ink area factor of 100% on the printed matter, to thus determine a new value P of  $Bk_{100}$ ;

finding an addition value  $\alpha_{100}$  for  $Bk_{100}$  in accordance with the following equation:

$$\alpha_{100} = \min(C_{100}, M_{100}, Y_{100}) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ ;

adding the addition value  $\alpha_{100}$  to  $Bk_{100}$  as well as setting all of  $C_{100}$ ,  $M_{100}$  and  $Y_{100}$  to 0; and

repeating, with respect to  $n$  from 99 to 1, the following steps of:

determining  $\min(C_n, M_n, Y_n)$  from color values  $(C_n, M_n, Y_n, Bk_n)$  of the proof printing image data for representing, on the proof print, a part having a black ink area factor of  $n\%$  on the printed matter;

determining an addition value  $\alpha_n$  with respect to  $Bk_n$  in accordance with the following equation:

$$\alpha_n = (\min(C_n, M_n, Y_n) - (100 - n)) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus add the addition value  $\alpha_n$  to  $Bk_n$ ; and

obtaining respective reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  of  $C_n$ ,  $M_n$  and  $Y_n$  in accordance with the following equations:

$$\beta_n = \alpha_n \times ((P - Bk_{100}) / C_{100}),$$

$$\gamma_n = \alpha_n \times ((P - Bk_{100}) / M_{100}), \text{ and}$$

$$\delta_n = \alpha_n \times ((P - Bk_{100})/Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus subtract the reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  from  $C_n$ ,  $M_n$  and  $Y_n$ , respectively.

8. A color proofing apparatus for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press by the use of a computer, the color proofing apparatus comprising:

a look-up table creating section for creating a look-up table including converted values of image data over the entire color space with respect to the proof press;

a noise strength and distribution amount input section for setting the noise strength and distribution amount indicating the level of a variation of the color of the printing paper for the printing press;

a paper color input section for specifying the color of the printing paper for the printing press;

a look-up table correcting section for correcting the look-up table based on the color inputted to the paper color input section and a paper exposed area factor in the proof print and

an image data converting section for changing the image data converted by the use of the look-up table corrected by the look-up table correcting section based on the noise strength and distribution amount inputted to the noise strength and distribution amount input section, to thus output the changed image data.

9. The color proofing apparatus according to claim 8, wherein in the case where the proof print is produced based on only area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink

transmittance into account, the look-up table correcting section includes:

a paper exposed area factor calculating section for determining a paper exposed area factor  $\alpha$  in accordance with the following equation when arbitrary reference data P in the look-up table has color values (Cp, Mp, Yp, Bkp), each of which is N-bit data:

$$\alpha = (1 - C_p / (2^N - 1)) \times (1 - M_p / (2^N - 1)) \times (1 - Y_p / (2^N - 1)) \times (1 - B_{kp} / (2^N - 1)),$$

in contrast, determining the paper exposed area factor  $\alpha$  in accordance with the following equation when the arbitrary reference data P in the look-up table has the color values (Cp, Mp, Yp, Bkp), each of which is percentage data:

$$\alpha = (1 - C_p / 100) \times (1 - M_p / 100) \times (1 - Y_p / 100) \times (1 - B_{kp} / 100); \text{ and}$$

a color corrected value calculating section for determining corrected values (Ci', Mi', Yi', Bki') of color values (Ci, Mi, Yi, Bki) of arbitrary reference data I in the look-up table in accordance with the following equations when color values (Ca, Ma, Ya, Bka) of the printing paper for the printing press are added to a part where a paper exposed area factor is 100%:

$$C_i' = C_i + C_a \times \alpha, M_i' = M_i + M_a \times \alpha, Y_i' = Y_i + Y_a \times \alpha \text{ and } B_{ki}' = B_{ki} + B_{ka} \times \alpha,$$

to thus replace the color values of the reference data with the corrected values.

10. The color proofing apparatus according to claim 8, wherein in the case where the proof print is produced based on both of density gradation and area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink transmittance into account, the look-up table correcting section includes:

an influence range input section for specifying an influence range defining

how far reference data is influenced in the color space when the color values of the printing paper for the printing press are added to the color space; and

an influence value calculating section for determining an influence value for each of the reference data based on the color values of the paper and the value of the influence range, to thus add the influence value to the reference data.

11. The color proofing apparatus according to claim 8, wherein in the case where the colors of the printing paper for the printing press and a printing paper for the proof press are different from each other to such an extent as to need to take the ink transmittance into account, the look-up table correcting section includes:

a second color corrected value calculating section for determining corrected values (Ci', Mi', Yi', Bki') of color values (Ci, Mi, Yi, Bki) of arbitrary reference data I in the look-up table in accordance with the following equations when color values (Ca, Ma, Ya, Bka) of the printing paper for the printing press are added to a part where a paper exposed area factor is 100%, wherein address values (Cid, Mid, Yid, Bkid) express the color values (Ci, Mi, Yi, Bki) by N-bit:

$$Ci' = Ci + Ca \times (1 - Cid/(2^N - 1) \times Mid/(2^N - 1) \times Yid/(2^N - 1) \times Bkid/(2^N - 1));$$

$$Mi' = Mi + Ma \times (1 - Cid/(2^N - 1) \times Mid/(2^N - 1) \times Yid/(2^N - 1) \times Bkid/(2^N - 1));$$

$$Yi' = Yi + Ya \times (1 - Cid/(2^N - 1) \times Mid/(2^N - 1) \times Yid/(2^N - 1) \times Bkid/(2^N - 1)); \text{ and}$$

$$Bki' = Bki + Bka \times (1 - Cid/(2^N - 1) \times Mid/(2^N - 1) \times Yid/(2^N - 1) \times Bkid/(2^N - 1));$$

to thus replace the color values of the reference data with the corrected values.

12. A color proofing apparatus for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press by the use of a computer, the color proofing apparatus comprising:

an image data input section for receiving an input of proof printing image data over the entire color space in a subtractive process resulting from color

matching between proof print produced by the proof press and the printed matter produced by the printing press; and

an image data correcting section for correcting the proof printing image data, in which each of levels of monochromatic color gradation of black on the printed matter is represented on the proof print, out of the image data inputted to the image data input section in such a manner that a part having a black ink area factor of 100% on the printed matter is represented only with black ink also on the proof print, but that a part other than the part having a black ink area factor of 100% on the printed matter is represented on the proof print by using under color removal, to thus output the corrected image data.

13. The color proofing apparatus according to claim 12, wherein the image data correcting section includes:

a 100% black part image data correcting section for determining  $\min(C_{100}, M_{100}, Y_{100})$  from color values  $(C_{100}, M_{100}, Y_{100}, Bk_{100})$  of the proof printing image data for representing, on the proof print, the part having the black ink area factor of 100% on the printed matter, to thus determine a new value P of  $Bk_{100}$ , determining an addition value  $\alpha_{100}$  for  $Bk_{100}$  in accordance with the following equation:

$$\alpha_{100} = \min(C_{100}, M_{100}, Y_{100}) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ , and then, adding the addition value  $\alpha_{100}$  to  $Bk_{100}$  as well as setting all of  $C_{100}$ ,  $M_{100}$  and  $Y_{100}$  to 0; and

a 99% or less black part image data correcting section for repeating, with respect to  $n$  from 99 to 1, the following processes of:

determining  $\min(C_n, M_n, Y_n)$  from color values  $(C_n, M_n, Y_n, Bk_n)$  of the proof printing image data for representing, on the proof print, a part having a black ink area factor of  $n\%$  on the printed matter;



determining an addition value  $\alpha_n$  for  $Bk_n$  in accordance with the following equation:

$$\alpha_n = (\min(C_n, M_n, Y_n) - (100 - n)) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus add the addition value  $\alpha_n$  to  $Bk_n$ ; and

determining respective reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  of  $C_n$ ,  $M_n$  and  $Y_n$  in accordance with the following equations:

$$\beta_n = \alpha_n \times ((P - Bk_{100}) / C_{100}),$$

$$\gamma_n = \alpha_n \times ((P - Bk_{100}) / M_{100}), \text{ and}$$

$$\delta_n = \alpha_n \times ((P - Bk_{100}) / Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus subtract the reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  from  $C_n$ ,  $M_n$  and  $Y_n$ , respectively.

14. A recorded medium recording therein a color proofing program for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press by the use of a computer, the color proofing program instructing the computer to execute the processes of:

creating a look-up table containing converted values of image data over the entire color space with respect to the proof press;

correcting the look-up table based on the color of printing paper for the printing press and a paper exposed area factor in the proof print; and

creating proof print by the use of the corrected look-up table.

15. The recorded medium recording therein the color proofing program according to claim 14, wherein in the case where the proof print is produced based on only area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink transmittance into account, the look-up table correcting

process includes the processes of:

determining a paper exposed area factor  $\alpha$  in accordance with the following equation when arbitrary reference data P in the look-up table has color values (Cp, Mp, Yp, Bkp), each of which is N-bit data:

$$\alpha = (1 - C_p / (2^N - 1)) \times (1 - M_p / (2^N - 1)) \times (1 - Y_p / (2^N - 1)) \times (1 - B_{kp} / (2^N - 1)),$$

in contrast, determining the paper exposed area factor  $\alpha$  in accordance with the following equation when the arbitrary reference data P in the look-up table has the color values (Cp, Mp, Yp, Bkp), each of which is percentage data:

$$\alpha = (1 - C_p / 100) \times (1 - M_p / 100) \times (1 - Y_p / 100) \times (1 - B_{kp} / 100); \text{ and}$$

determining corrected values (Ci', Mi', Yi', Bki') of color values (Ci, Mi, Yi, Bki) of arbitrary reference data I in the look-up table in accordance with the following equations when color values (Ca, Ma, Ya, Bka) of the printing paper for the printing press are added to a part where a paper exposed area factor is 100%:

$$C_i' = C_i + C_a \times \alpha, M_i' = M_i + M_a \times \alpha, Y_i' = Y_i + Y_a \times \alpha \text{ and } B_{ki}' = B_{ki} + B_{ka} \times \alpha,$$

to thus replace the color values of the reference data with the corrected values.

16. The recorded medium recording therein the color proofing program according to claim 14, wherein in the case where the proof print is produced based on both of density gradation and area gradation and the colors of the printing paper for the printing press and a printing paper for the proof press are approximated to each other to such an extent as not to need to take the ink transmittance into account, the look-up table correcting process includes the processes of:

specifying an influence range defining how far reference data is influenced in the color space when the color values of the printing paper for the printing press

are added to the color space; and

determining an influence value for each of the reference data based on the color values of the paper and the value of the influence range, to thus add the influence value to the reference data.

17. The recorded medium recording therein the color proofing program according to claim 14, wherein in the case where the colors of the printing paper for the printing press and a printing paper for the proof press are different from each other to such an extent as to need to take the ink transmittance into account, the look-up table correcting process includes the processes of:

determining corrected values ( $C_i'$ ,  $M_i'$ ,  $Y_i'$ ,  $B_{ki}'$ ) of color values ( $C_i$ ,  $M_i$ ,  $Y_i$ ,  $B_{ki}$ ) of arbitrary reference data I in the look-up table in accordance with the following equations when color values ( $C_a$ ,  $M_a$ ,  $Y_a$ ,  $B_{ka}$ ) of the printing paper for the printing press are added to a part where a paper exposed area factor is 100%, wherein address values ( $C_{id}$ ,  $M_{id}$ ,  $Y_{id}$ ,  $B_{kid}$ ) express the color values ( $C_i$ ,  $M_i$ ,  $Y_i$ ,  $B_{ki}$ ) by N-bit:

$$C_i' = C_i + C_a \times (1 - C_{id}/(2^N - 1) \times M_{id}/(2^N - 1) \times Y_{id}/(2^N - 1) \times B_{kid}/(2^N - 1));$$

$$M_i' = M_i + M_a \times (1 - C_{id}/(2^N - 1) \times M_{id}/(2^N - 1) \times Y_{id}/(2^N - 1) \times B_{kid}/(2^N - 1));$$

$$Y_i' = Y_i + Y_a \times (1 - C_{id}/(2^N - 1) \times M_{id}/(2^N - 1) \times Y_{id}/(2^N - 1) \times B_{kid}/(2^N - 1)); \text{ and}$$

$$B_{ki}' = B_{ki} + B_{ka} \times (1 - C_{id}/(2^N - 1) \times M_{id}/(2^N - 1) \times Y_{id}/(2^N - 1) \times B_{kid}/(2^N - 1));$$

to thus replace the color values of the reference data with the corrected values.

18. The recorded medium recording therein the color proofing program according to any one of claims 14 to 17, wherein the proof print creating process includes the process of:

changing image data converted by using the corrected look-up table based on the previously determined noise strength and distribution amount indicating the

level of a variation of the color of the printing paper for the printing press, to thus create the proof print by the use of the changed image data.

19. A recording medium recording therein the color proofing program for improving the color reproducibility of printed matter to be produced by a printing press in proof print produced by a proof press by the use of a computer, the color proofing program further instructing the computer to execute the process of:

correcting proof printing image data, in which each of levels of monochromatic color gradation of black on the printed matter is represented on the proof print, out of the proof printing image data over the entire color space in a subtractive process resulting from color matching between proof print by the proof press and the printed matter by means of the printing press in such a manner that a part having a black ink area factor of 100% on the printed matter is represented only with black ink also on the proof print, but that a part other than the part having a black ink area factor of 100% on the printed matter is represented on the proof print by using under color removal, to thus reproduce, on the proof print, the representing characteristics of the black ink on the printed matter.

20. The recorded medium recording therein the color proofing program according to claim 19, wherein the proof printing image data correcting process includes the processes of:

determining  $\min(C_{100}, M_{100}, Y_{100})$  from color values  $(C_{100}, M_{100}, Y_{100}, Bk_{100})$  of the proof printing image data for representing, on the proof print, the part having the black ink area factor of 100% on the printed matter, to thus determine a new value P of  $Bk_{100}$ ;

determining an addition value  $\alpha_{100}$  for  $Bk_{100}$  in accordance with the following equation:

$$\alpha_{100} = \min(C_{100}, M_{100}, Y_{100}) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ ;

adding the addition value  $\alpha_{100}$  to  $Bk_{100}$  as well as setting all of  $C_{100}$ ,  $M_{100}$  and  $Y_{100}$  to 0; and

repeating, with respect to  $n$  from 99 to 1, the following processes of:

determining  $\min(C_n, M_n, Y_n)$  from color values  $(C_n, M_n, Y_n, Bk_n)$  of the proof printing image data for representing, on the proof print, a part having a black ink area factor of  $n\%$  on the printed matter;

determining an addition value  $\alpha_n$  for  $Bk_n$  in accordance with the following equation:

$$\alpha_n = (\min(C_n, M_n, Y_n) - (100 - n)) \times (P - Bk_{100}) / \min(C_{100}, M_{100}, Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus add the addition value  $\alpha_n$  to  $Bk_n$ ; and

determining respective reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  of  $C_n$ ,  $M_n$  and  $Y_n$  in accordance with the following equations:

$$\beta_n = \alpha_n \times ((P - Bk_{100}) / C_{100}),$$

$$\gamma_n = \alpha_n \times ((P - Bk_{100}) / M_{100}), \text{ and}$$

$$\delta_n = \alpha_n \times ((P - Bk_{100}) / Y_{100}),$$

wherein  $1 \leq P \leq 100$ , to thus subtract the reduction values  $\beta_n$ ,  $\gamma_n$  and  $\delta_n$  from  $C_n$ ,  $M_n$  and  $Y_n$ , respectively.